AN EXPERIMENT IN

SUPPLEMENTARY BOTANY.

De Scholis Silvisque.

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To the Registrar of the University of Toronto:

We beg to report that the thesis by W. H. Muldrew, entitled "An Experiment in Supplementary Botany," considered in connection with the answers given by him to the questions presented in the Examination, entitles him to the degree of Doctor of Pedagogy, and that according to the Statute of the University regarding the ranking of candidates for the degree, he is to be placed in the second-class of Honors.

JOHN WATSON.

J. A. McLELLAN.

PREFACE.

In submitting the following pages it is assumed that the desideratum in the present connection is some contribution to practical pedagogy; and it is believed that the position here defended is fairly representative of whatever may be original in the work of the writer. It is hoped that its value is not lessened by the fact that it was developed originally with no thought of its serving as an academic exercise; but took form gradually under the influence of a two-fold interest in the growing mind and in the life of Nature. That the subject is an humble one is cheerfully admitted, and its author pleads in extenuation only that his is an humble profession which hopes by attention to little things to accomplish great results.

"There is no evil in education greater than teaching subjects so that their actual bearing is lost sight of: teaching them as if they were mere studies instead of real bodies of fact. The divorcing of knowledge obtained by study in school from that obtained spontaneously out of school is one of the things the teacher must be most constantly on his guard against. Children may study geography and not find out that they are simply extending and classifying the knowledge about the world that they have been getting ever since they were born; they may study history without realizing that they are but enlarging their knowledge of real men and real deeds; they may study grammar without finding out that they are simply defining and analysing what they have always had some practical knowledge of. All is remote, arbitrary, and, consequently, meaningless and burdensome. None of the educational reforms of the last generation has been more important than that in primary methods which has connected STUDIES *with ordinary ways of gaining knowledge and with ordinary kinds of knowledge."—Applied Psychology.*

I.

INTRODUCTORY.

"Ne sutor supra crepidam."

The position of a teacher in a remote country town offers but few advantages for the prosecution of literary research. Far removed from libraries and centres of learning, with little of leisure and less of means, and finding his chief interest in services which to most people appear tedious in the extreme, he might well be content to leave the elucidation of theoretical matters to those working under more favorable conditions. And truly the world need seldom find reason to complain of such a determination. There is in recent educational literature no lack of theories and counter-theories; and it would seem but a doubtful service to a busy profession to add new systems of generalizations, capable at most of indirect application to practical teaching.

But there is a field of enquiry that is ever near him, and in which he *must* learn if he will not close his eyes. Day by day he follows the development of young minds struggling to master an ever-widening circle of ideas; he notes their interests, their difficulties and their triumphs. He shares with them the pleasure of success or humiliation of defeat, ever seeking the causes for both alike in the matter or the method of his work.

To such an one there is nothing more suggestive than the study of transition-stages in the growth of knowledge: those critical periods where the mind is led into what may seem new regions, but which are, and *must* be, in reality, merely developments based on the old. For no school-master ever laid the foundation of a knowledge of any science, or art, or language. The foundations were present before him or the structure would never have arisen. But while the beginnings are independent of the teacher it is his to guide the progress; and his success or failure must largely depend on the skill with which he uses the material supplied by the past experience of the learner.

These ideas are seen in very many of our educational precepts, and are recognized more or less in all modern methods of teaching. The doctrine of apperception, the enforcement of which seems the permanent contribution of the Herbartians, is generally recognized. We no longer present the rules of Latin in Latin nor both before the mother-tongue, and we laugh at the Hibernian who proposes to begin his arithmetic at the end, that he may the sooner be over the difficult parts. The only serious objection is offered by those who fear that studies will lose all their value if made easy or interesting (and such they must become when rightly presented), forgetting that power comes from the conquest of real and necessary, rather than artificial or accidental, difficulties.

The introduction to secondary studies in our High Schools offers many special problems to the observant teacher, in all of which the fundamental consideration must be the relation of the new to the old. The algebra that grows out of the simplest arithmetic without reference to abstract definitions will not prove a bugbear ; and a boy or girl interested, however faintly, in the business of parents or friends need never hate book-keeping. Here is made the beginning of systematic natural science ; and it is proposed to illustrate the practical application of such principles to the transition from nature as known in youthful experience to the science of the class-room.

We make no extravagant claims as to the pre-eminent value of such studies ; but, assuming that Botany as limited by our present secondary course furnishes *one* valuable means in the hands of the teacher, we propose to develop certain of its aspects which seem too much neglected in our classes. Neither do we think it necessary to dwell upon the commonly recognized features of our general topic ; our object being rather to show that by a certain simplification of our traditional methods in accordance with recognized principles we may intensify the values attaching to our present treatment of the subject.

II.

THE PROBLEM.

"Induct him, therefore, in such a way as to knit each new thing on to some acquisition already there; and if possible awaken curiosity so that the new thing shall seem to come as an answer or part of an answer to a question pre-existing in the mind."—James' Psychology.

A seeming community of interest between the learned naturalist and the simple child appears to be responsible for our almost universal practice of making the floral organs the beginning as well as the end of elementary botany. It is true that to both of these enthusiastic observers the flower is the central fact of the plant; but it is equally true that they are attracted to it by interests quite opposite, if, indeed, not exclusive. For while the blossom appeals to the opening mind, as to its old allies the bees and butterflies, merely by its beauty of form and color, the mature student reads in it the results of the long struggle for existence manifested in relations on which is based his all-absorbing system of classification.

We need scarcely wonder that hopes founded on this fictitious agreement are often doomed to disappointment. The primitive interest is too easily lost in the struggle with the minute and intricate analysis of the floral organs, aggravated by an accompaniment of difficult names. The higher interest gains strength but slowly in the presence of so much that is unfamiliar, and the learner who began with enthusiasm too often continues with indifference.

There is, however, another interest lyingmidway between these extremes and serving to some extent as their connecting link. Teachers of botany have long realized the value of the incentive furnished by the instinct for identification and naming coupled with the the classification that is thus rendered possible. At the same time the supremacy of the floral organs in our botanical texts and Floras has rendered this stage impracticable until the student has made a very considerable advance in the power of observation and the mastery of technical terms. For this reason the first months spent by the beginner in botany form a very critical period; there he may develop an enthusiasm for nature-studies to color his whole life, or an indifference to chill all future effort.

That the wrong result does sometimes follow in spite of good teaching cannot be denied; and this is especially to be deplored at the threshold of the observing sciences which should be of absorbing inter-

est to the young student. The difficulty is increased by the fact that our classes commence work in the autumn when simple forms are not easily obtained in sufficient numbers, particularly in our northern localities; while the long winter months very soon put practical flower-study out of the question.

Now, no one denies that the floral organs form the culmination while best exhibiting, in general, the relations of the individual and the species; but it seems to us a very different thing to assume on this account that they furnish the best material for those with no previous experience in careful observation or identification. In addition to the lack of interest for which this traditional introduction is too often responsible, the practical effects of its one-sidedness are in many ways painfully evident. Since identification is based almost solely on the flower-structure which is usually in existence for only a few days in the year (while even then its analysis is often beyond the powers of the tyro), the practical knowledge of young botanists is commonly limited to plants with conspicuous flowers met under most favorable conditions and in the presence of Key and Flora.

That such is the case is nowhere more apparent than in the attitude of even competent collectors towards our common trees. Only last summer we had the pleasure of meeting an enthusiastic botanist from the city of New York who had spent his vacations for years in botanical collecting, but who knew almost nothing of the trees, and was perfectly satisfied with the explanation that his business did not permit of fieldwork in spring and early summer! To come nearer home we may mention the candidate who at a recent Senior Leaving Examination in practical Botany identified a spray of White Pine in full foliage and in flower as a species of Equisetum! And passed "very creditably," too! The same weakness appears continually in the graduates of our Botany classes and is not unknown among the teachers themselves. It seems that from their very commonness the trees are persistently neglected in the schools; and, with the exception of an occasional analysis of the flowers or a passing reference as illustrating the forms of fruit or foliage, the sylva of our woods has no existence for our classes. This is the natural result of our exaltation of what may be termed flower-botany. The floral organs of the trees are often as inconspicuous as they are transitory and difficult of access and they are *practically* excluded from examination requirements.

One effect on the learner has been pointed out; but it does not end with himself. Can we wonder at the distrust for school-learning which is apt to follow the admission by a science graduate that he cannot distinguish the Spruce from the Balsam or the Soft from the Sugar Maple? The fact that he may be able to point out subtle differences in the flowers will not save him; popular philosophy ex-

pects him to know his subjects as well as to know about them, and its demand is surely not unreasonable.

Now, is it too much to ask that our High School students as a part of the year's course that begins and ends school Botany in about eighty per cent. of the cases, should form some practical acquaintance with the sylva of their neighborhoods? Is there any point of view from which it will appear of less value to discriminate between the species of Quercus than those of Orchis? And if it can be shewn that such an extension of our subject, instead of interfering with our usual course may rather be made its most powerful ally, need any one hesitate to acknowledge its claims?

Here, as elsewhere in Nature-study, identification rendered secure by a name, is the essential mental nucleus around which must gather the results of the study of a species. Knowledge of a thing not represented in consciousness by a symbol is as transitory as it is indefinite and disconnected. We are aware that efforts have been made to slight the value of such a personal acquaintance with objects of Nature; and it has even been alleged that a good knowledge of Botany may be gained without *knowing* in this sense a single species. It might be worth while to suggest the extension of such principles to other departments; and it would be interesting to follow the growth of a mind nurtured on the Geography of a world of anonymous lands and Literature with unknown authors, to say nothing of History with nameless kings and heroes. Meanwhile practical teachers are at one with psychology and common sense in insisting that exact naming of an object is a condition of exact organized knowledge about it. The craving of the young mind for the names of all things within its experience furnishes a strong *a priori* argument to the same effect; and this interest is very wisely made use of in all natural science teaching where naming is made possible by means of Keys or Analyses which direct the efforts of the learner.

This double value of identification as furnishing a spur to observation and comparison as well as providing a definite point of reference for future knowledge is very widely recognized in the teaching of Botany; so that a Key with a classified Flora is now practically our only text-book. This very fact seems to have led to a curious confusion in the minds not of students alone but of some masters as well; until it has become quite common to speak of identification which is the beginning as if it were synonymous with the classification that should be its highest fruit. Bain tells us that "to learn to classify is itself an education;" but this certainly does not apply to the process of following a given form to its place in a pre-arranged system. Such is *one* means of identification and with a distinct value, but ought never to be confounded with the process of generalization through recognized agreements in the midst of diversity. The ideal

classification for educational purposes would be made by the student himself from materials supplied by his previous observations and identifications with a minimum of assistance from teacher and text-book, instead of having such forced upon him in a ready-made system. Such is, of course, largely precluded alike by the common and Linnæan nomenclatures which imply the relationships of species.

In the meantime a definite acquaintance with individuals is a necessary condition of classification in any true sense; and we are thus led to a consideration of means for identification so far as concerns our present subject. Here, as throughout the vegetable world, the traditional approach is through the floral organs, though we may safely affirm that such is as rare in practice as it is universal in theory. How many students, e.g., have made the acquaintance of our native Beech by way of Apetalous Angiosperms, staminate flowers in catkins, deciduous bracts, calyx bell-shaped, and, at the same time, fruit consisting of nuts enclosed in a burr? Such facts are eminently suitable for more mature powers of observation as they are essential for natural classification, but for *identification* they are to a beginner practically useless. Further, it is only when such features are studied as belonging to a form already known (in the popular sense) that they reach their highest value.

A few years ago we had the privilege of assisting a practical botanist of thorough preparation and long experience in making a collection of the seeds of northern trees and shrubs for the Vanderbilt Arboretum at Biltmore, S.C. Our united struggle with the species and varieties of Amelanchier, Vaccinium, Nemopanthes, Cornus, Viburnum, etc., were not easily forgotten; and soon lead to an attempt to find some means of identification of more permanent application than that based on the never-present floral organs.

We sought aid from books with little satisfaction; for though we found two authors who had approached the trees somewhat as we proposed, their methods were not suitable at least for beginners. While the one (1) merely divided the genera into a few large groups (one of which contained nearly fifty species), the other (2) was obliged to fall back upon the inflorescence before making final distinctions. We have not examined any similar works dealing with the shrubs. The explanation is at once suggested that the problem *in such general terms* is insoluble, and that the characters independent of the inflorescence are not sufficiently distinctive and constant to render possible the determination of the sylva of half a continent.

However, comparatively few amateurs are interested in such cosmopolitan research; and it occurred to us that the commonly

1—The Trees of North-Eastern America.-Newhall, New York, 1890.

2—Trees of the Northern United States.-Apgar, New York, 1892.

occurring trees and shrubs *of a given locality* might be worked out in such a form as to make their identification fairly easy and certain in the absence of their transient flowers. It seemed that such an arrangment while of value to the botanist and collector would be specially suitable for beginners of any age. The trees form a common ground between the empirical lore of childhood and the more exact science of the schools. Many of them are old and cherished acquaintances. Long before the boy heard of Botany he gathered the fruit of beech and hazel, of haw and Juneberry, of raspberry and blueberry and many more, as much to satisfy his nascent scientific curiosity as his omnivorous appetite. He admired the birch canoe with contributions from half a dozen of his forest friends, the paddle of bird-eye maple or cherry and the gaudy baskets woven of splints pounded from the wood of the black ash. He learned to make spring-whistles of the young basswood and possibly even essayed a primitive cigar cut from the porous root of a white elm "tip-up," or devoured the "slippery" inner bark of its red brother. Nor is his more timid sister quite a stranger to such wood-lore; she has at least stripped the paper from the white birch to grace a dainty letter and gathered the glowing leaves of the oak and the red maple in the autumn woods. Teachers would sometimes be surprised to learn how many such disjointed facts exist in the minds of their dullest scholars; and a boy with his "contempt for small things" can hardly be blamed for thinking that a Botany which prefers the "flower in the crannied wall" to the patriarch of the forest is the extreme of perversity.

If from such a basis we are able to widen and deepen and organize such knowledge shall we not have made a fitting introduction to systematic Botany besides gaining a result of distinct value in itself? But how can such be accomplished? Here, as elsewhere, desultory teaching is of small value. It is easy to present a number of disconnected lessons on leaves, bark, flowers, fruits, etc. but such lose much of their educational value when not directed towards some central principle capable of sustaining the interest and unifying the results of observation and study. Such a principle is found in identification, supported by the naming instinct and followed by classification from which, however, it must be clearly distinguished.

Our position then is briefly this: that the best material for introducing an autumn class of beginners to formal Botany is to be found in connection with a study of our native trees and shrubs; and that such a study should include a systematic identification based on the observation of the more obvious and relatively permanent characters, leading gradually and naturally to methods at once more general and more special.

Then must we neglect our old friends the flowers for the sake of this hobby-horse? By no means. Everything in its place; and

we hope to shew later on that one of the best features in our suggested course is the fact that it needs but little teaching and therefore interferes scarcely at all with other work, or even with other hobbies.

The foliage is easily accessible and abundant throughout September and October and may be readily preserved for winter use. Its main features are plain enough to be easily made out by the most inexperienced, while finer distinctions at a later stage may tax the discrimination of the cleverest. It lends itself peculiarly to that most important ally of observation, viz., drawing, for those of whom we write have but limited powers of perspective representation and find quite enough difficulty at first in reproducing accurately and fully a very ordinary leaf. The relatively greater permanence of the leaves brings with it many advantages: we may be pretty sure of finding any required species as we last saw it, and are thus always prepared for review or comparison and enabled to introduce new forms in any desired order. Here too the field is not too wide; few localities present more than fifty species of trees or twice that number of shrubs and the youthful collector may confidently look forward to a fairly complete acquaintance with the whole circle within a very short time.

If with a minimum of teaching such determination of species can be made so easy and satisfactory as not to discourage, yet hard enough to furnish a healthy stimulus, pupils will be able by their own efforts not only to become familiar with the sylva of their neighborhood but to acquire that habit of accuracy and certainty in observation which is the foundation of all proficiency in natural science. Then when this practical experience, advancing side by side with a gradually widening knowledge of flower-structure, has cleared the way for higher methods, the learner finds himself already familiar with a large number of common forms to be studied at the proper time as old acquaintances under a new aspect. In this, as in other relations, it will be seen that our purpose is always to supplement and never to supplant the study of flowers as now prosecuted in our classes.

It may be urged that such a system is of necessity artificial, and therefore to be condemned off-hand. It will, however, be time enough for such objections when any branch of the classificatory sciences is able to dispense with such aids. If keys are necessary for trained observers in all departments how much more for the first lessons in the first field of investigation. We have botanized with naturalists of a generation almost gone, who were trained under the highly artificial system of Linnaeus, but their observations were none the less acute nor their ideas of classification less definite on that account. The main fact to be kept in mind has been emphasized above in the necessary distinction between identification and classification.

With such ends in view we set to work a few summers ago to attempt the preparation of what might be termed a Key, but which we preferred to call an Index, as better befitting a simple guide to a most interesting chapter of the book of nature. We aimed at simplicity in arrangement and terminology without sacrifice of exactness; and after much discouragement leading to renewed efforts we feel that the desired result has been practically attained. The present form as determined by actual use with several classes of beginners is given on page 14 *et seq.*, and its marked success as an introduction to the subject seems to justify the hope that in abler hands it may be extended to other districts with equal satisfaction and advantage. Its claims are based primarily on its relations to the teacher's art, but experience shews its independent value to the amateur botanist as supplementary to the more extensive Floras.

Some explanation may be necessary as to the principles followed in the arrangement. The uniform basis selected was the leaf-characters as being at once the most permanent and most suitable for young observers while admirably adapted for class-use and capable of being preserved indefinitely. The primary distinctions made, as being most constant, were between simple and compound forms, followed by the mode of arrangement and the peculiarities of margin, or, in compound leaves, of division. The cone-bearing species form a well-marked group by themselves. The various combinations of these features give the divisions which bring the first semblance of order into the materials before the beginner; while their discrimination is so simple as to give rise at once to the desire for further advance along similar lines. The subdivisions of these groups are made according to the most obvious features, each agreement being followed by a step to the right on the page until the botanical name of the species under consideration is reached. The common names are not given here, first, because of their tendency to induce jumping (or rather "skipping") to conclusions, and, second, because the name just discovered tends by that very fact to be firmly associated with its object. The affixed numbers, however, give the common names in a succeeding list and an additional column gives the page of Spotton's High School Botany (Third Edition) for further reference. For obvious reasons the nomenclature of this text has been followed throughout.

The progress is direct to the species. This arrangement, together with the fact that each minor group is made *exclusive* as well as *inclusive*, while adding greatly to the difficulties of preparation makes a corresponding simplification in using the index, and obviates the necessity for the stars, pointers and letters which contribute so much to the confusion of the tyro. In the majority of cases the

species is reached through the generic group but such has not been found possible in all cases, while the marked variability of certain characters has sometimes rendered necessary the repetition of a species under different headings. The stimulus given to observation of such peculiarities has itself a well-marked value that receives but scant encouragement from the standard text-books, which indeed, are often far from satisfactory in their qualifications outside of floral characters, as can be testified by any one who has attempted much identification of species not in bloom. Their sins of omission are naturally the more numerous but others are by no means wanting.

The scope of the work has been already outlined. It proposes to include merely those forms to be met within a few miles of the school for which it has been prepared. The interest of the botanist has been throughout secondary to that of the pedagogue; and it is hoped that the work owes more to the woods and the class-room than to the lamp and the library.

III.

SEEING, THINKING, NAMING AND KNOWING.

"Every object, every thing, becomes such for the child by the word. Before the word was given the thing had no existence for the child though his outer eye seemed to perceive it. The word created as it were the thing for the child."—Froebel.

"The only things which we commonly see are those which we preperceive, and the only things which we preperceive are those which have been labelled for us and the labels stamped into the mind."—James.

"If the word without the idea is empty, the idea without the word is little better than an airy nothing without a local habitation and a name."—McLellan.

"It is, I repeat, universally admitted that for a general or abstract notion, the essential preparation is the particulars."—Bain.

COMMON TREES AND SHRUBS OF

AN INDEX BASED ON THE LEAVES.

If description agrees, step to right : if not, step down.

		*	†
COMPOUND-OPPOSITE.			
Climbing shrub, leaflets in 3's, clinging by petioles.	Clematis Virginiana	59	3
Sharply serrate, leaflets stalked, mostly downy beneath, shrubs.			
Leaflets 5-11, long-tapering, stems soft, heart white.	Sambucus Canadensis	21a	97
Leaflets 5-7, bark warty, stem woody, heart brown.	Sambucus racemosa	21b	97
Leaflets sessile, finely serrate, nearly smooth, trees.	Fraxinus sambucifolia	36c	182
Leaflets stalked, not sharply serrate, trees.			
Petioles and branchlets smooth, pale beneath, nearly entire.	Fraxinus Americana	36a	181
Petioles and branchlets pubescent, finely toothed.	Fraxinus pubescens	36b	181
COMPOUND-ALTERNATE-PINNATE ; leaflets 5 or more.			
Stipules long and narrow, joined along petiole, leaflets 5-9.			
Stems unarmed or nearly so, under 3 feet high.	Rosa blanda	11a	72
Stems prickly, leaves pubescent beneath, teeth fine.	Rosa Carolina	11b	71
Stipules awl-shaped and erect, leaflets 5 or 3, side ones not stalked.	Rubus strigosus	10a	70
Stipules not present, trees or large shrubs, leaflets 11 or more.			
Leaves twice-pinnate, stem low and bristly, scarcely woody.	Aralia hispida	17	92
Branchlets and petioles smooth, leaflets 13-15.	Pyrus Americana 13a		74
Branchlets and petioles thickly soft-hairy, leaflets 11-31.	Rhus typhina	3a	44
Branchlets and petioles downy, leaflets 11-17, large tree.	Juglans cinerea	39	202
COMPOUND-ALTERNATE-PALMATE or of only 3 leaflets.			
Stems unarmed, mostly climbing or trailing or straggling.			
Leaflets 3, notched, or toothed, or crenate.			
Petiole long, mostly 2 in. or more, teeth few, poisonous.	Rhus toxicodendron	3b	44
Petiole short, ½ 2in., (mostly 1 in or less), crenate, sweet-scented.	Rhus Canadensis	3c	44
Leaflets 5, coarsely serrate, climbing or trailing, harmless.	Ampelopsis quinquefolia	5	45
Stems thorny or prickly, erect or reclining.			
Leaflets 3 or 5-palmate, stalked, end stalk longest, prickles bent.	Rubus strigosus	10a	70
Leaflets 3 or 5-palmate, stalked, end stalk longest, prickles bent.	Rubus villosus	10b	70
Stems thorny or prickly, trailing or prostrate, leaflets 3-7.			
Stems shrubby, trailing, prickles scattered, leaves thin.	Rubus Canadensis	10c	71
Stems hardly woody, bristly, prostrate, leaflets thick and shining.	Rubus hispidus	10d	71

* See list of Common Names at end of Index.

† Page of Spotton's High School Botany Pt. II., Ed. III.

SIMPLE-OPPOSITE-ENTIRE.

Ovate and taper pointed or acute, mostly ½ 2 in. long.			
Leaves large, round-ovate, woolly beneath, in rich woods.	Cornus circinata	18a	93
Leaves narrowly ovate, silky-downy beneath, twigs downy.	Cornus sericea	18b	94
Base rounded, surface rough, finely pubescent, twigs reddish.	Cornus stolonifera	18c	94
Leaves mostly finely toothed and blunt-tapering.	Viburnum cassinoides	22b	97
Leaves mostly with stipules or in 3's, sharply taper-pointed.	Cephalanthus occidentalis	23	100
Oval or oblong, not taper-pointed, mostly obtuse.			
Upper leaves united, stems usually twining.			
Leaves glaucous beneath, oblong.	Lonicera parviflora	19a	96
Leaves downy hairy beneath, large and broadly oval.	Lonicera hirsuta	19b	96
Upper leaves not united, stems not twining.			
Leaf-margin ciliate, stems much branched.	Lonicera ciliata	19c	96
Leaf-margin revolute, leaves small, low marsh shrub.	Kalmia glauca	32	143

SIMPLE-OPPOSITE-SERRATE or TOOTHED, not lobed.

Really opposite, all leaves and most branches, shrubs.			
Finely serrate, margin ciliate, no stipules, low and erect.	Diervilla trifida	20	97
Very large, round-cordate, veins beneath rusty or woolly.	Viburnum lantanoides	22f	98
Coarsely toothed, pubescent beneath, mostly with stipules.	Viburnum pubescens	22c	97
Finely toothed or nearly entire, blunt-tapering, smooth.	Viburnum cassinoides	22b	97
Finely serrate, petiole margined, taper-pointed, tree-like.	Viburnum Lentago	22a	97
Apparently opposite (only some of the leaves, branches alternate)			
See Simple-Alternate-Serrate, especially Betula and Prunus.			

SIMPLE-OPPOSITE-LOBED.

Petiole coarse with stipules and glands, scattered hairs beneath.	Viburnum Opulus	22e	98
Petiole 1 in. or less, mostly with narrow stipules, thickly downy.	Viburnum acerifolium	22d	98
Lobes 3, long tapering, finely 2-serrate, bark striped.	Acer Pennsylvanicum	7a	47
Sinuses rounded and entire, or notched at inmost point, large trees.			
Sinuses broadly rounded, lobes with 5 teeth or less, pale beneath.	Acer saccharinum	7c	47
Sinuses deep, notched, lobes with many teeth, silvery beneath.	Acer dasycarpum	7d	48
Sinuses not rounded, not deep, not entire, margin serrate, notches acute.			
Nearly smooth, pale beneath, mostly 2-serrate, twigs reddish.	Acer rubrum	7e	48
Downy beneath, coarsely serrate, with wrinkled appearance.	Acer spicatum	7b	47

Simple-Alternate-Entire.

Climbing by stipules, stem very bristly, veins curving.	Smilax hispida	59	237
Trailing or prostrate or reclining.			
With wintergreen flavor, pointed, revolute, bristly beneath.	Chiogenes hispidula	26	141
With wintergreen flavor, often serrate, teeth bristle-pointed.	Gaultheria procumbens	29	141
Stems very slender, leaves ½ in. or less, revolute, pale beneath.			
Stems ¼ 1 ft. long, leaves about ¼ in. ovate, acute.	Vaccinium Oxycoccus	25a	139
Stems 1-3 ft. long, leaves about ½ in. oblong, obtuse.	Vaccinium macrocarpon	25b	140
Leaves round-cordate, stems bristly, petioles slender, evergreen.	Epigæa repens	28	141
Leaves obovate, thick, evergreen, stem much branched.	Arctostaphylos Uva-ursi	27	141
Very downy or woolly beneath, not rusty, not strongly revolute, often toothed or wavy.			
Small, not ¼ ½ in. x 1½ in. downy on both sides and on twigs.	Vaccinium Canadense	25d	140
Often wavy or toothed or slightly revolute, width mostly ¼ ⅜ in.	Salix humilis	49e	211
Often unevenly serrate, veins plain, width mostly ¼ ⅜ in.	Salix livida	49d	211
Strongly revolute, white or rusty brown beneath, low marsh shrubs.			
White-glaucous beneath, narrow, mucronate, evergreen.	Andromeda polifolia	31	142
Rusty woolly beneath, oblong, obtuse, twigs downy.	Ledum latifolium	33	142
Erect shrubs, nearly smooth, not strongly revolute.			
Petiole very short, less than ¼ in.			
Width 1 in or more, obtuse, twigs tough, tipped by leaves.	Dirca palustris	37	194
Resinous-dotted, base acute, oval, mucronate.	Gaylussacia resinosa	24	139
Small, leathery, often rusty beneath, or finely toothed.	Cassandra calyculata	39	142
Petiole ½ in. or more, ends acute, veins curved, often slightly toothed, or pubescent beneath.	Cornus alternifolia	18d	94
Petiole ¼ in. or more, slender, often purplish, leaves oblong, sometimes slightly toothed or mucronate.	Nemopanthes Canadensis	35	145

Simple-Alternate-Lobed.

Pinnately lobed, fragrant when crushed, fern-like shrub.	Comptonia asplenifolia	41	204
Sinuses acute, shrubs or small trees.			
Branches thorny or spiny.			
Base not cordate, thorns 1 in. or longer, tall shrub.	Cratægus coccinea	12	72
Base cordate or square, thorns ½ in. or less, at leaf bases.	Ribes cynosbati	15a	75
Branches unarmed, shrubs.			
Reclining shrub, deeply lobed, ill-scented when crushed.	Ribes prostratum	15c	76
Erect shrub, resinous-dotted beneath, not offensive.	Ribes floridum	15b	76
Sinuses rounded, large trees.			
Lobes acute and bristle-pointed.	Quercus rubra	42c	206
Lobes obtuse and rounded.			
Smooth and pale or slightly glaucous beneath.	Quercus alba	42a	205
White hoary beneath, low ground.	Quercus bicolor	42b	205

Simple-Alternate-Serrate or Toothed or Crenate.

SIMPLE-ALTERNATE-SERRATE or Toothed or Crenate *(Continued.)*

Narrow, pointed, mostly ½–2 in. long, teeth fine, glaucous or woolly or *very* glossy beneath, twigs slender, bark bitter. (Willows).			
Woolly beneath, teeth irregular, veins very plain, tall shrub.	Salix livida	49d	211
Glossy on both sides, apex long-tapering, petiole with glands.	Salix lucida	49b	210
Apex long-tapering, base acute, width mostly ¼–⅜ in. pale beneath.			
Silky-glaucous beneath, 2-3 in. long, a shrub in wet places.	Salix petiolaris	49f	211
Slightly glaucous beneath, 3-5 in. long, tree with dark bark.	Salix amygdaloides?	49a	210
Apex not tapering, width mostly ½–¾ in. glaucous beneath.			
Base acute, length ½–3 in. unevenly serrate, tall or tree-like.	Salix discolor	49e	210
Base round or cordate, length ¼–3 in. teeth fine, shrub, twigs yellow-brown and shining.	Salix balsamifera	49g	212
Toothed at apex only, nearly sessile, oblanceolate, very fragrant.	Myrica Gale	40	203
Small, ¼–⅜ in. x 1½ in. teeth very fine, petiole very short, small marsh shrubs.			
Shining on both sides, teeth bristly, branchlets green and warty.	Vaccinium Pennsylvanicum	25e	140
Pale and glaucous beneath, teeth very fine, thin, not leathery.	Vaccinium nigrum?	25e	140
Leathery, often rusty beneath, or nearly entire, or revolute.	Cassandra calyculata	30	142
Long and pointed, teeth fine, base not entire not cordate, petiole mostly with glands or teeth. (Cherries).			
Teeth strongly incurved, trees with dark or reddish bark.			
Teeth very unequal, mostly, 20 or more per in.	Prunus Pennsylvanica	8b	64
Teeth about 15 per in. leaves large, petiole rather stout.	Prunus serotina	8d	64
Teeth slender, not incurved, oval or obovate, abruptly tapering, tall shrub.	Prunus Virginiana	8e	64
Base round or cordate, entire near petiole, teeth abruptly pointed,, petiole mostly ½–½ in. without glands.	Amelanchier Canadensis	14a	74
Base mostly acute and entire near petiole, shrubs in moist soil.			
Teeth fine and sharp nearly all round, not widening toward apex, acute, not tapering.	Amelanchier oligocarpa	14c	74
Teeth strongly incurved, fine and close, midrib with glands above, mostly obovate and taper-pointed.	Pyrus arbutifolia	13b	74
Densely woolly beneath and on twigs, dark green above.	Spiræa tomentosa	9b	65
Pale and smooth beneath, closely serrate except lower third.	Spiræa salicifolia	9a	65
Pale beneath, narrow, wedge-lanceolate, teeth few, mainly above middle, mostly obtuse.	Prunus pumila	8a	64
Glossy green above, veins downy beneath, obovate, pointed, bitter, teeth fine and sharp.	Ilex verticillata	34	145
Oblong or oval, toothed near apex only, petioles slender and often purple, very bitter.	Nemopanthes Canadensis	35	145

Leaves very small, without distinct blade, linear, needle-shaped, awl-shaped or scale-like. mostly evergreen, bunched or scattered or arranged in rows on the branches. (Pines, Cedars, Spruces, etc.)

Needles all in clusters of 2 or 5.

In clusters of 5, a large tree.	Pinus strobus	51c	215
In clusters of 2, 3-5 in. long, large tree, bark reddish.	Pinus resinosa	51a	215
In clusters of 2, about 1 in. long, a small tree	Pinus Banksiana	51b	215
Needles in clusters of more than 5, or solitary on new twigs, not evergreen	Larix Americana	55	216
Needles all solitary, sessile, 4-edged, not flat, pointing in all directions, i.e. all around the branches.			
Branchlets downy, leaves dark or slightly glaucous.	Picea nigra	52a	215
Branchlets smooth, leaves pale or glaucous.	Picea alba	52b	215
Leaves all solitary, flattened, pointing mostly right and left on level branches.			
Apex rounded, paler beneath, trees.			
Leaves sessile, midrib dark beneath.	Abies balsamea	54	216
Petiole short and oblique, very pale beneath.	Tsuga Canadensis	53	216
Apex very acute, both sides dark green, low shrub.	Taxus baccata	58	216
Leaves in circles of 3, prickly pointed, pale above, low shrub.	Juniperus communis	57a	216
Leaves awl-shaped or scale-like.			
Mostly opposite, awl-shaped and loose or scale-like and close.	Juniperus Virginiana	57b	216
Overlapping like shingles in 4 rows on flat branchlets.	Thuja occidentalis	56	216

COMMON NAMES.

1 Virgin's Bower.
2 Basswood, Linden.
3a Sumach, Staghorn Sumach.
3b Poison Ivy.
3c Aromatic Sumach.
4 Frost Grape.
5 Virginia Creeper.
6 Wax-work, Climbing Bitter-sweet.
7a Striped Maple, Moosewood.
7b Mountain Maple, Shrub Maple.
7c Hard Maple, Sugar Maple.
7d Soft White Maple, Silver Maple.
7e Soft Red Maple, Swamp Maple.
8a Dwarf-cherry.
8b Pin-cherry, Wild Red Cherry.
8c Choke-cherry.
8d Wild Black Cherry.
9a Common Meadow-sweet.
9b Downy Meadow-sweet, Steeple-bush.
10a Wild Red Raspberry.
10b High Blackberry, Thimble-Berry.
10c Low Blackberry, Dew-Berry.
10d Running Swamp-Blackberry.
11a Early Wild Rose.
11b Swamp Rose.
12 Hawthorne.
13a Mountain Ash.
13b Black Choke-Berry.
14a June-Berry, Bill-Berry.
14b Round-leaved June-Berry.
14c Swamp June-Berry.
15a Wild Gooseberry.
15b Wild Black Currant.
15c Fetid Currant, Skunk-berry.
16 Witch-Hazel.
17 Bristly Sarsaparilla.
18a Round-leaved Dogwood.
18b Silky Dogwood.
18c Red Osier Dogwood.
18d Alternate-leaved Dogwood.
19a Small Glaucous Honeysuckle.
19b Hairy Honeysuckle.
19c Fly-Honeysuckle.
20 Bush Honeysuckle.
21a Common Elder.
21b Red-Berried Elder.
22a Sheep-Berry, Nanny-Berry.
22b Withe-rod.
22c Downy Arrow-wood.
22d Maple-leaved Arrow-wood.
22e High-Bush Cranberry.
22f Hobble-Bush.
23 Button Bush, Water Dogwood.
24 Black Huckleberry.
25a Small Cranberry.
25b Large Cranberry.
25c Dwarf Blueberry, Blue Huckleberry.
25d Canadian Blueberry.
25e Low Black Huckleberry.
26 Creeping Snow-berry.
27 Bear-berry.
28 Trailing Arbutus, May-Flower.
29 Wintergreen.
30 Leather-Leaf.
31 Wild Rosemary.
32 American Laurel.
33 Labrador Tea.
34 Holly, Winter-Berry, Fever-Bush.
35 Mountain Holly.
36a White Ash.
36b Red Ash.
36c Black Ash.
37 Leather-wood, Moose-wood.
38 White Elm.
39 Butternut.
40 Sweet Gale.
41 Sweet Fern.
42a White Oak.
42b Swamp White Oak, Blue Oak.
42c Red Oak, Black Oak.
43 Red Beech, White Beech.
44 Beaked Hazel Nut.
45 Ironwood.
46 Blue Beech.
47a Black or Sweet Birch.
47b Yellow Birch.
47c White Birch, Paper or Canoe Birch.
48 Speckled or Hoary Alder, Tag-Alder.
49a Black Willow.
49b Shining Willow.
49c Glaucous Willow.
49d Livid Willow.
49e Prairie Willow.
49f Petioled Willow.
49g Balsam Willow.
50a Small-leaved Poplar or Aspen.
50b Large-toothed Aspen or Poplar.
50c Balsam Poplar, Balm of Gilead.
51a Red Pine.
51b Northern Scrub Pine, Gray Pine.
51c White Pine.
52a Black Spruce.
52b White Spruce.
53 Hemlock, Hemlock Spruce.
54 Canada Balsam, Balsam Fir.
55 Larch, Tamarac.
56 White Cedar.
57a Juniper.
57b Red Cedar.
58 Ground Hemlock.
59 Bristly Smilax, Cat-Brier.

TIMES OF FLOWERING—*Approximate.*

In	April	we	may	look	for	No's	1 to 25.
"	May	"	"			"	6 " 50.
"	June	"	"			"	21 " 57.
"	July	"	"			"	41 " 59.
"	October	"	"			No.	60.

1 Populus.
2 Larix.
3 Ulmus.
4 Acer (rubrum and dasycarpum)
5 Rhus (Canadensis.)
6 Epigæa.
7 Salix.
8 Taxus.
9 Juniperus.
10 Tsuga.
11 Alnus.
12 Betula.
13a Ostrya.
13b Carpinus.
14 Corylus.
15 Fagus.
16 Juglans.
17 Comptonia.
18 Myrica.
19 Dirca.
20 Amelanchier.
21 Fraxinus.
22 Prunus.
23 Crataegus.
24 Pyrus.
25 Ribes.
26 Nemopanthes.
27 Acer { saccharinum. Pennsylvanicum. spicatum.
28 Picea.
29 Thuja.
30 Abies.
31 Quercus.
32 Ledum.
33 Andromeda.
34 Cassandra.
35 Arctostaphylos.
36 Chiogenes.
37 Kalmia.
38 Celastrus.
39 Rhus (typhina).
40 Gaylussacia.
41 Vaccinium.
42 Smilax.
43 Sambucus.
44 Viburnum.
45 Lonicera.
46 Cornus.
47 Rubus.
48 Vitis.
49 Tilia.
50 Pinus.
51 Ilex.
52 Gaultheria.
53 Cephalanthus.
54 Diervilla.
55 Aralia.
56 Rosa.
57 Spiraea.
58 Ampelopsis.
59 Clematis.
60 Hamamelis.

CONCLUSION.

A school-master who has no hobby, no subject which he teaches with special sympathy and with contagious enthusiasm, loses a great opportunity for influence.—Fitch.

If the work outlined in previous chapters had ended there, this essay would never have been written. There is a well-grounded suspicion directed against theories in general and pedagogical theories in particular; and a critical audience has the right to demand the results of such proposals in actual practice. For some years we have made such a course the means of approach to systematic science, and have found it in every way a most satisfactory vantage-ground from which to approach the higher methods, besides giving immediate results of great interest and value. It remains to outline in briefest form a year's work from such a beginning.

Throughout the early autumn we meet daily in half-hour lessons. The wholesome interest of youth in the presence of a new field of enquiry makes the first lessons especially favorable for the laying of broad foundations. Here then are developed the general aims of Botany and its relations to other branches of study; the essentials of of the plant with its broad distinctions from the animal and the inorganic worlds; and the elements of classification and naming as illustrated by such common forms as the Maples and Raspberries. Then follow lessons in observation and description introducing the terms necessary to distinguish Kinds, Arrangements and Margins (or Modes of division) of leaves. In a few days a three-word description can be given or written for any presented form on sight: e.g., Simple-Opposite-Lobed or Compound-Alternate-Pinnate. The descriptive terms gradually increase in number with the increase in seeing-power of the class till a full and fairly accurate description can be made without hesitation. Then the Index, carefully copied into a notebook

of pocket size, is introduced and little more is needed except material. No trouble is experienced in finding volunteers to provide the latter when such services are needed, and henceforth, while prosecuting the examination of flowers or fruits or seeds, a few minutes daily are devoted to identification, description, and drawing of the leaves of common trees, with the discussion of such facts of interest as they may suggest, with the result that before the woods are bare our beginners have carefully examined and identified more species than previously in the full school year. Specimens have been collected and put in press for winter use and a large number of trees and shrubs have been transplanted bodily into our extensive grounds for the reference and study of future classes. Considerably more than half the species here given are now represented in this way within our own domain. And all this largely as a pastime, outside of school hours, and requiring a minimum of time and attention from the teacher. At an examination given about this time, the pupils are required to identify twelve specimens (6 being new to class-work) being allowed two minutes for each. The determinations prove correct in about seventy per cent. of the cases; which might be considered a fair average for a *floral* analysis with the full time given to one specimen, and this after a year of preparation.

With the advent of winter this work is suspended in the interest of more purely indoor departments; but later the dried specimens are mounted and carefully re-identified, described and drawn as seatwork exercises. In the spring the Key and Flora present little difficulty to those accustomed to the simpler Index, and while the spring flowers are examined and identified a list of flowering times (see page 21) makes possible the examination of this new aspect of previous acquaintances which if unknown are too often passed unseen. Now, too, the fuller significance of the relations suggested by names and leaf-resemblances are recognized through the floral structure, and the principles of classification are brought home in a way that can scarcely be mistaken.

It may be said that an exposition, professing to be practical, should take some account of results as tested by Examinations; and it is an unfortunate fact that methods are too often judged by their bearing on this feature of our work. However, no one need fear our proposals on that score; though the matter learned may never be required at a Departmental Examination the *method* is essential, and in two junior classes prepared by a year's course such as we have outlined there has not been a failure in Botany or otherwise.

We have already mentioned some of the advantages which seemed, from purely theoretical considerations, to belong to such an introduction to our subject as has been outlined. Now that we have examined the practical working of these suggestions it will be in order

to treat more fully the causes of their success as being in harmony with recognized principles of education.

The foundation of natural science is laid in exact observation, and it is of primary importance to provide that from the outset the beginner shall be supplied with an abundance of material suitable for his stage of advancement and with a proper incentive to its use. The leaves as here treated prove admirably adapted to both of these requirements. No one thinks of introducing exact solid geometry with only a passing reference to the properties of plane figures; then why ask children to plunge into the mysteries of the three-dimensioned flower structure when their experience has not yet fitted them to make an adequate comparison of two simple leaves? The order of nature is a much abused principle but here assuredly we make no mistake; experience shews that after such a training in the simpler forms the floral organs are mastered in a much briefer time and with comparative ease. To those who insist that the value of school-work depends on its irksomeness and difficulty (whether real or unnecessary) we can only reply that we begin with the simple in order that we may in due time master the complex, with the easy that the most difficult may thereby become finally possible.

In these studies, as throughout education, the value of self-activity can hardly be over-estimated; and here we have found it possible within a very few days from the beginning of a student's experience in Botany to enable him to answer through his own sustained observation many of the interesting questions with which nature surrounds us. This result is made possible in a similar way though at a much later stage by the analysis of the flowers; but with the difference that the difficulties inherent in the material here seriously limit the field of successful activity. Most students retain in later years a vivid recollection of specimens that could not be traced, steps that could not be arrived at by observation, and perhaps, worst of all, plants thrown aside as not belonging to the prescribed families and so, presumably, either too difficult or unworthy of attention. Such experiences cannot fail to be highly injurious to the young investigator. Similar stumbling-blocks may be found in the index here presented; but we are convinced that all such *can* be avoided by a wider knowledge of the forms involved and of the beginner's apprehension of them.

One of the arguments commonly advanced in favor of Botany as a subject of study is its tendency to counteract the intense application to books and to bring the learner into direct contact with nature. The subject as here treated lays special emphasis on this aspect; the woods are never more attractive than in September and October, and what more fitting close could be imagined for a day at school and books than a ramble among the trees note-book in hand

and thus with just enough of the intellectual to add zest to the recreation? In our experience it has been no uncommon thing to have presented on Monday morning interesting specimens carried home from the Saturday expedition, in the game-bag intended for more sanguinary trophies—yet apparently with no less satisfaction. Here we exercise the taste for collecting, which is essential to our system for winter-work, and which is not without educational value in itself.

The question of winter-botany is of perennial interest to our teachers under present conditions as is shewn by frequent papers and discussions at the meetings of the Natural Science Section of our Provincial Teachers' Association. It is recognized that dried specimens of flowers are of little use for elementary classes while the time and trouble of preparing such in sufficient numbers and of properly caring for them would be a serious charge upon a teacher. Fruits and seeds may in many cases be so preserved with good results, but the foliage is the feature pre-eminently fitted for such treatment. With the aid of a few drying-papers a board and a weight almost perfect specimens can be provided with a minimum of trouble; these mounted on stout cards about one foot square with arbitrary numbers furnish excellent material for drawing, description, and determination, during the bleak winter months. Supplementary to such work is the examination of winter buds with the marks, mode of growth and many other noteworthy features of the naked branches. Then, too, our evergreen trees, so important from every point of view, yet perhaps least studied in our schools, can be discussed; and most interesting botanical expeditions are rendered possible even in mid-winter.

The relations of such work to other departments is a matter of interest; its relation to Drawing in particular being very noticeable. *Seeing* must be taught before *Drawing* becomes possible and such a course as described will not fail to awaken at least the power of acute observation. On the other hand a new significance is given to the numerous nature-allusions of Literature when the objects of these have been met and studied from the scientific side. Our High School Reader contains upwards of fifty references to trees or shrubs such as are here described; and such are found on nearly every page of Scott and Wordsworth. For this reason we have found it very useful and interesting to require with each drawing and description a quotation from the School Readers, or some standard author, referring to the same topic. It is surprising to note in this connection how little some writers seem to really know of such objects of their allusions; while, on the artistic side, our national Maple Leaf is commonly represented either as that of a sister species unworthy of the honor, or as a hybrid such as never grew in Canada nor anywhere else.

We have emphasized throughout the value of a wholesome interest in subjects of study ; but the other side of this truth is equally important to the teacher. While interest is indispensable in the acquirement of knowledge we should never forget that knowledge is the leading condition of interest ; and there is no more unhappy man or woman than the one who, from a contracted habit of mind, is incapable of any interest beyond the things of self. Anything that we can do to broaden the ideas of those in our charge though it be but by stimulating an interest in common objects cannot fail to be of lasting advantage. It is almost axiomatic in education, that we learn with what we have learned, and we have seldom seen this truth better illustrated than in the new attitude of students to the flowers of a species already familiar through more permanent features. Usually our classes examine but few of the flowers of trees and shrubs ; being generally not conspicuous and lacking the interest born of previous acquaintance we frequently pass by or under such in full bloom while our eyes are fixed on the violets or lilies that grow beneath. But once knowing a given species and its time of flowering the case is changed ; and then there need never be any lack of such material for analysis from earliest spring till holidays and examinations put an end to such activities so far as school is concerned. The double meaning of identification by flowers with Keys and Flora, and by the leaves and note-book, adds much to the confidence of the beginner in his determination and inspire him with assurance in dealing with species that cannot be reached by the royal road which he is now rapidly outgrowing.

We have said that such work is not a direct preparation for any examination though indirectly its effects are very noticeable even here ; but we are satisfied that the identification of a number of common forms chosen from our arborescent flora would be a far greater guarantee of a practical knowledge of Botany than the present test supplies. The number of species in bloom at examination-time, which are adjudged simple enough for the first examination, is small for most localities ; and an enterprising class, with or without the aid of an enterprising teacher, can readily prepare in a few hours for the "identification" of a plant so strictly limited by nature and the Department of Education. Such a procedure has been very graphically described as "cornering" the available supply; but with more than a hundred species to choose from there need be no fear of such an abuse of the spirit of a practical examination.

Teachers are prone to grumble at their text-books, and science-teachers are certainly no exception to the rule. From the nature of the case it would seem that a text such as we recommend, and adapted to a given locality should be prepared by the science master of the school concerned. Only thus could it be given the best

form and freed from the encumbrance of unnecessary and confusing species. Here is scope for the original work of the teacher; and as there could be no necessity for printing, much less stereotyping, the succeeding editions, gradual improvement would be made until each teacher possessed at least *one* text book that was ideally perfect! Such is far from the case with the results of the work of the writer herewith presented; but if it shows the *possibility* of such an arrangement, its purpose here will be accomplished. This possibility, indeed, we have frequently heard denied in conversation with teachers who should be well qualified to judge; and this conviction accounts for the fact that, so far as we know, such a method as here outlined has not been attempted elsewhere. We believe, however, that the problem has been approached (as previously suggested) in terms unnecessarily wide; though the quintic in general be beyond our powers of analysis, we may yet be able to solve such an equation under certain limitations of the involved coefficients. Of one thing we may be assured: a master whose work in this direction has stood the test with boys and girls who persist in seeing things as they *appear* without reference to what anyone may have said *about* them, will have gained an experience that must stand him in good stead throughout his science classes; and, further, will have gained some appreciation of the difficulties which beset any attempt to bring the diversity of nature within the comprehension of beginners by means of verbal description.

We hear much nowadays about nature-study in the public schools; but, unfortunately, the Nature thus advocated is usually as indefinite as that of Jean Jacques Rousseau. Enthusiasts too often forget that the universal must be attained through the particular in which it is implied and the teacher is left in darkness as to practicable means for cultivating that love of Nature which he is so earnestly exhorted to instil. To us it seems that the logical way to prepare children for an appreciation of the book of nature is to put them in the way of reading it for themselves, and hence that any real progress in nature-teaching must lie along such lines as are here suggested by making plain how scientific methods may be applied to the material that is everywhere before the teacher. We believe that such work in the department here treated can be done by anyone capable of teaching efficiently the three r's; and this without formally adding to a curriculum already over-burdened, since such activities properly guided prove rather a relaxation than an added burden to a healthy young mind, and are of necessity treated apart from the regular tasks.

In conclusion then this introduction can be heartily recommended to teachers, not as an innovation but as a supplement to the ordinary course which will more than repay any extra trouble it may

entail. We feel justified in asserting that the year in botany which limits the nature-study of the great majority of secondary students may be more than doubled in permanent value by such means. As suggested above the subject is best treated locally, and we know of no more interesting undertaking than the arrangement of the sylvan flora of a neighborhood in some such form as is here given. Let no one suppose that this will be the amusement of a holiday afternoon: only a very considerable acquaintance coupled with patient comparison can produce results of practical value, and especial care is necessary in the elaboration of details in order to bring them within the reach of beginners.

But whatever may be the teacher's doubts as to the success of his work in the hands of his pupils he may well be assured that its effect on himself will be altogether good. The woods will have for him a new interest no less in October than in May; he will welcome the flowers when he meets them as before but such will no longer be essential to his attention. He will find in a new intimacy with old acquaintances a circle whose widening by a new discovery will be quite as gratifying as the addition of another orchid to the known flora of his neighborhood. And it is to be hoped that, in spite of certain contrary tendencies, he may thus realize more fully than before, that it is but a narrow Botany which regards the plant and its flower as a narrow mediæval Theology regarded the body and the soul.

We have spoken of this introduction throughout in its application to school work, but there is no reason why its usefulness need be confined to the school. There are in every neighborhood intelligent lovers of nature whose casual observations are largely rendered vain by a want of method. To such the simplest available manuals are commonly impracticable without a systematic course of preparation; but a system such as we have outlined has been found quite practicable for anyone with a modicum of zeal and ordinary education. By such means we may do something to foster an interest in nature-study beyond the class-room, and thus help to draw together the schools and the people to their mutual advantage.

This essay was prefaced with a plea for these humble phases of knowledge; and we cannot do better than close with a reference to the way such are apprehended alike by the highest poetry and the deepest philosophy of our age. We are all familiar with the thought of Tennyson as voiced in the "Flower in the Crannied Wall," and so we are told by one of our leading exponents of Idealism, that "Since nothing is apart from the unalterable nature of the one Being that comprehends all reality, to understand completely the nature of the simplest form of existence.....is to apprehend it as one of the phases in which the absolute intelligence is manifested. It is this that makes all pursuit of knowledge sacred. In learning the properties of a simple blade of grass we are partially apprehending the nature of God."

$$\frac{x_1 x_2}{(x_1+x_2)^2} \le \frac{(1-x_1)(1-x_2)}{(2-x_1-x_2)^2} = \frac{1-(x_1+x_2)+x_1x_2}{4-4(x_1+x_2)+(x_1+x_2)^2}$$

$$4x_1x_2 - 4x_1x_2(x_1+x_2) \le (x_1+x_2)^2 - (x_1+x_2)^3$$

$$\Rightarrow x_1^3 - x_1^2x_2 - x_1x_2^2 + x_2^3 - x_1^2 - x_2^2 + 2x_1x_2 \ge 0$$

$$\Rightarrow x_2^3 - x_1^2x_2 - x_1x_2^2 + x_2^2 - (x_1-x_2)^2 \le 0$$

$$\Rightarrow x_1^2(x_1-x_2) - x_2^2(x_1-x_2) - (x_1-x_2)^2$$

$$= (x_1-x_2)(x_1^2-x_2^2-x_1+x_2)$$

$$= (x_1-x_2)^2(x_1+x_2-1) \le 0$$

$$\frac{\sum x_1}{(\sum x_1x_2+x_1x_2)^2} \Rightarrow \frac{\sum x_1}{(x_1^2x_2^2+x_2^2x_3^2+x_3^2x_1^2)^2} \ge \frac{\sum x_1}{(\sum x_1)^4}$$

$$\frac{(1-x_1x_2)(1-x_2x_3)}{\le (2-x_1x_2-x_2x_3)^2}$$

2 x1x2 ≤ x1+x2